May 29, 1956 I. KRAMER 2,747,258

METHOD OF ASSEMBLING HEAT TRANSFER COILS

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Fig. 1.

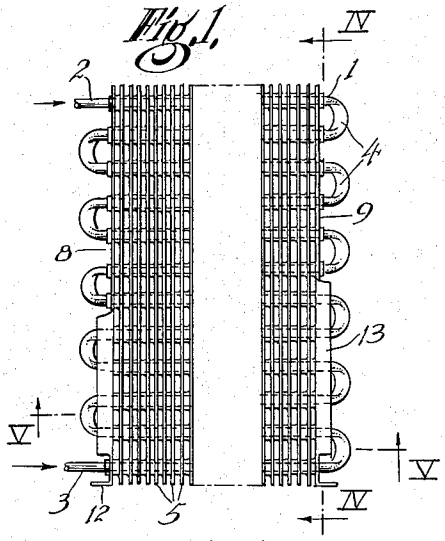


Fig. 2.

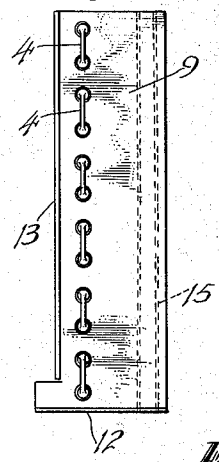


Fig. 4.

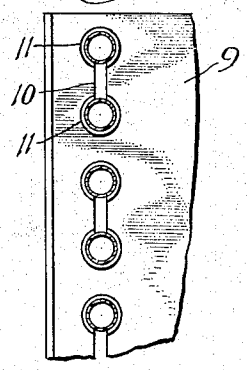


Fig. 3.

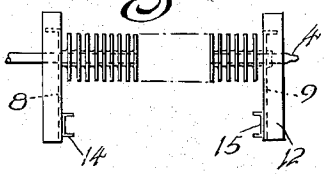


Fig. 5.

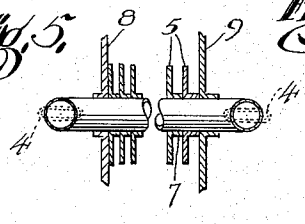


Fig. 6.

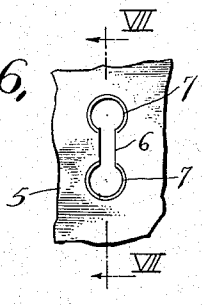


Fig. 8.

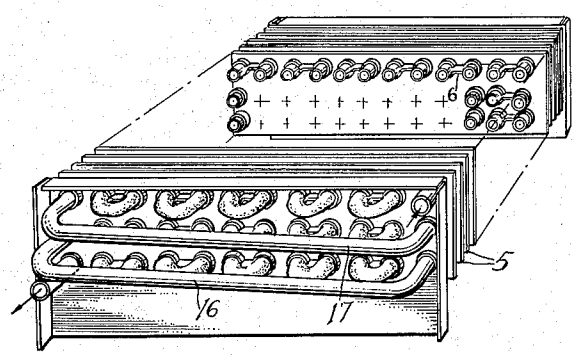
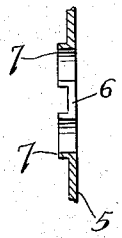


Fig. 7.



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METHOD OF ASSEMBLING HEAT TRANSFER COILS

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Application November 13, 1952, Serial No. 320,188

5 Claims. (Cl. 29—157.3)

This invention relates to a method of assembling heat tarnsfer coils such, for instance, as are used in evaporators and condensers of refrigerating and air conditioning apparatus; and the invention has for an object to provide such a method which facilitates rigid union of the tube, fins and header plates, which latter serve the purpose of securing and holding the coil in proper position within a unit, or the like, such as a window fitting, during transportation and during operation following installation when it is subject to vibratory effects from compressor, motor and fan.

Another object is to provide such a method in which the tube can be assembled with the whole group of fins to be positioned thereon by relative motion of the parts, the header plates be thereafter slipped over the bends of the tube at opposite ends of the group of fins, and the whole be firmly united in rigid assembly by expansion of the tube.

Another object is to provide such a method in which fins and header plates composed of aluminum, or other metal that is not readily solderable, can be firmly united with a tube composed of copper, or the like, by expansion of the latter following assembly of the parts.

Another object is to provide such a method in which fins composed of very thin gauge stock can be used without danger of distorting or otherwise damaging them when the parts are assembled.

Another object is to provide such a method in which a tube of sinuous or serpentine form can be used without the necessity of separate return bends, so that, following the assembly of tube, fins and header plates, there is no requirement for the attachment of additional elements other than cross-over connections or a manifold if a plurality of tube sections or rows is employed.

Another object is to provide such a method which lends itelf to simplicity, expedition and economy, while attaining to a high degree the objects hereinabove named as well as other advantages that inhere in the invention.

Practical embodiments of coils and parts thereof assembled according to the present invention are shown in the accompanying drawings, in which

Fig. 1 represents a broken side elevation of a tube with its group of fins and header plates assembled thereon before re-expansion of the return bends;

Fig. 2 represents an elevation at right angles to Fig. 1, looking from right to left;

Fig. 3 represents an end elevation of the parts shown in Fig. 1, looking from the bottom toward the top;

Fig. 4 represents an enlarged detail section taken in the plane of the line IV—IV of Fig. 1, looking in the direction of the arrows;

Fig. 5 represents an enlarged broken detail section taken in the plane of the line V—V of Fig. 1, looking in the direction of the arrows and showing the return bends as flattened in dotted lines and as re-expanded in full lines;

Fig. 6 represents a further enlarged fragmentary detail of one of the fins, showing the form of the aperture

therein which accommodates a pair of the parallel runs of the tube and is adapted to slip over the return bend connecting said tube runs;

Fig. 7 represents a section taken in the plane of the line VII—VII of Fig. 6, looking in the direction of the arrows; and

Fig. 8 represents a broken perspective view, on the same scale as Fig. 1, showing a modified form of the finished coil in which the tube consists of three sections or rows connected by cross-overs to constitute a single fluid conduit.

As is well understood in this industry, heat transfer coils such as condensers and evaporators commonly consist of a metal tube in sinuous or serpentine form having a series of straight parallel runs lying in the same plane and connected at their ends by U-shaped return bends. The latter are sometimes separate pieces soldered to the straight runs, but it is preferable to form the tube in a continuous length with integral return bends. On the runs of the tube are mounted a large number of thin metal fins that have laterally projecting collars or flanges for uniformly spacing the fins and bettering their thermal contact with the tube. To complete the assembly a pair of header plates are mounted on the tube at opposite sides of the group of fins, the said plates being of sturdy construction and designed, not only to impart unitary strength to the assembly, but also to serve the important purpose of securing and holding the parts rigidly in position during transportation and in operation following installation in, for instance, an air conditioning window unit. Frequently the assembly includes a plurality of tube sections or stacks or rows, each consisting of the parallel runs and return bends, with the ends of adjacent sections connected by cross-over tubes soldered thereto in order to establish a continuous channel for the refrigerant fluid which, in all cases, is supplied to one end of the tube and withdrawn from the other when the apparatus is in use.

In the commercial production of these coils the method of assembly is an important factor because the fins are of very thin gauge material that is easily damaged, the procedure must be expeditious to reduce cost, and the finished article must have its parts firmly united and be very rigid and enduring. The fins and header plates are provided with apertures fitted to receive the tube, and it is common practice to expand the tube by internal fluid pressure after assembly in order to set up a hugging or gripping contact between the parts. When the tube, fins and header plates are composed of metal such as copper or brass, the assembly may also be dipped in a bath of solder after appropriate treatment of the contacting areas to improve the rigidity of the union, but this is not feasible when any of the parts is composed of metal such as aluminum.

In United States patent to Nathan Kramer No. 2,462,511, dated February 22, 1949, there is disclosed a method of assembling the tubes and fins of coils for condensers or the like, in which each section or row or stack of the tube is formed in a continuous one plane length with integral bends, the latter at one side of the coil are flattened in the direction of the plane of the tube, the fins are provided with apertures corresponding in shape with the combined cross section of two of the parallel runs of the tube and the connecting flattened bend, and a group of fins is mounted on the tube at one time by relative movement of the tube and fins which causes the flattened bends to pass through the fin apertures and the fins to be seated on thee parallel runs of the tube; following which the assembly is dipped in solder after suitable treatment of the contacting surfaces. But in the said patent there is no provision for mounting the header plates upon the tube or for fixing them rigidly in posi-

tion thereon; although in practice it has been customary to provide header plates with elongated apertures having curved ends and parallel sides spaced apart a distance slightly greater than the outside diameter of the tube, the length of the apertures being sufficient to embrace two adjacent parallel runs of the tube, which header plates were slipped into position on the tube after the fins were in place thereon and secured in position by solder dip after appropriate treatment of the contacting surfaces. This procedure has been commercially practicable when the header plates and fins, like the tube, were composed of copper, but it is not practicable in the case of aluminum header plates and fins for the reason that the solder bath is not effective with that material. To solve this problem, I have resorted to expanding the tube by internal fluid pressure, e. g., hydraulic, after the aluminum fins and header plates were in position, and, while this step served the purpose in respect to fixing the fins in position, it was not satisfactory with respect to fixing the header plates as the latter had a tendency to loosen during transportation with the result of being improperly positioned when put into operation and also lacking capability of rigidly holding the coil relative to other elements of an air conditioning or refrigerating unit, such as the compressor, fan and motor.

I finally achieved a fully satisfactory solution of the entire problem through conception of the present invention, which involves flattening the return bends of the tube at both sides of the coil in a manner similar to the flattening of the bends at one side of the coil according to Patent 2,462,511; providing the header plates with apertures which conformed to the combined cross section of a flattened bend and the two parallel runs of the tube connected thereto; providing a group of fins of the desired number with apertures of the same shape; holding the said group of fins with their apertures in alignment as by placing them on a flat surface with a suitable holding means or placing them in a rack or magazine or comb; causing relative motion of the tube and group of fins so as to pass the flattened bends of the tube through the apertures of the fins and locate the latter on the straight runs of the tube; slipping a header plate over the flattened bends and onto the parallel runs of the tube at each side of the group of fins; positioning the header plates precisely by the use of a jig or the like; and then expanding the tube by internal fluid pressure, e. g., hydraulic, so as to force it into rigid locking contact with the apertures in the header plates and fins, this pressure also serving to return the flattened portions of the bends substantially if not entirely to their original circular cross sectional shape. In this way aluminum header plates and fins can be expeditiously, economically and very effectively assembled with and fixed upon the tube; and this, of course, is also true if the coil be formed of more than one section or row or stack of tubes, in which case the sections will be connected by cross-over tubes soldered thereto following the steps above recited in order to establish a continuous fluid conduit through the coil.

Referring now to the accompanying drawings, and particularly Figs. 1 through 7 thereof, a coil section composed in this instance of twelve parallel runs with the necessary connecting bends is denoted generally by **1**, and its refrigerant fluid inlet and outlet by **2**, **3**, respectively. The return bends are flattened in the direction of the plane of the tube, as well shown in Fig. 5, and, as all of them are flattened in the same way, it is deemed sufficient to mark one with the numeral **4**. It may here be mentioned that, while four numerals have been placed upon the tube to indicate various portions thereof, the tube is not composed of separate parts but is bent into shape from a continuous length of tubing. The group of fins is denoted as a whole by **5** and each fin is provided with a series of apertures **6** that correspond, though slightly larger, to the combined cross section of a flattened return bend and its two adjacent parallel runs of the tube, as clearly shown in Fig. 6, the said apertures being sufficient in number so that the fin can receive all the parallel runs and their connecting bends. Each fin also has laterally extending collars **7**, **7**, around those portions of its apertures which are fitted to receive the parallel runs of the tube for the purpose of uniformly spacing the fins with respect to each other when mounted on the tube.

The header plates are denoted by **8** and **9**, and each is composed of material of sufficient thickness to provide a high degree of strength and rigidity. In each plate is formed a series of apertures **10** which correspond in shape to the fin apertures **6**, hereinabove described, so that the said plates may be slipped over the return bends of the tube and be seated on the parallel runs thereof at each side of the group of fins after the latter are in place. Surronding the portions of the said apertures **10** which embrace the parallel runs of the tube are laterally and outwardly projecting collars or flanges **11**, **11**, which improve the bearing or seating of the plates on the tube. Each plate is further provided with horizontal and vertical flanges **12**, **13**, which are formed by bending over two edges of the plate and may have suitable holes (not shown) for the passage of fastening elements in order rigidly to secure the coil in its proper position in an apparatus or unit such, for instance, as a window unit of air conditioning apparatus. Finally, each plate has riveted or otherwise suitably secured thereto a channel piece **14**, **15**, which are intended as means for positioning the air filter and constitute no feature of the present invention.

The modified form of the invention shown in Fig. 8 is constructed in the same way as the form of Figs. 1 through 7 hereinabove described, except that there are three sections, rows or stacks of tube, which are connected by cross-overs **16**, **17**, to establish a continuous channel; and with the further exception that the fins and header plates are provided with three rows of apertures in order to accommodate the three sections of the tube. In assembling this modified form, I prefer to insert the tube sections through the group of fins one at a time in order to reduce the force requisite for this step, although it is possible to insert all three sections at one time.

With reference to both forms of the invention, the tube may be composed of copper or brass or of aluminum, and the fins and header plates may also be composed of copper or brass or aluminum, but I prefer to use soft copper for the tube and aluminum for the fins and header plates, the fins being of very thin gauge material and the header plates of much thicker and sturdier gauge.

Briefly restating the hereinbefore indicated method of producing and assembling the coil: the tube is bent into a single plane sinuous or serpentine form, as indicated in Fig. 1 of the drawings by procedure well known to operatives in this field, and the return bends **4** at both sides of the tube are flattened in the direction of the plane of the tube, as is well shown in Fig. 2. A group of fins is provided having apertures of the form hereinabove described and illustrated in Fig. 6. A pair of header plates is also provided having similar apertures and horizontal and vertical flanges, also in accordance with the previous description. A group of fins is arranged on a flat surface with suitable means holding them in group formation, or the group is similarly positioned with the apertures of the fins in alignment by the use of any suitable means, such as a magazine or comb or rack. The tube and group of fins are next moved relatively to each other, preferably by inserting the tube through the apertures in the fins until the return bends at each side of the group of fins project therefrom, as pictured in Fig. 1. The header plates are then slipped over the return bends at each side of the group of fins, as is also shown in Fig. 1. Finally, the tube is expanded, with prior annealing of the bends,

if preferred, by the injection of fluid pressure, e. g., hydraulic, thereinto of sufficient strength (e. g. approximately 3,000 pounds per square inch), to force the tube into close and very tight contact with the fins and header plates and impart the rigid characteristics of a unitary structure to the assembly; this internal pressure also serving largely, if not entirely, to eliminate the flattened parts of the return bends by re-expanding them to their circular cross section form, as is depicted in Figs. 5 and 8. If copper or brass is used for the tube, fins and header plates, the last mentioned step may be supplemented by dipping the assembly into a solder bath after suitable treatment of the contacting surfaces, but this is not regarded as an essential feature of my method and, as already explained, is not effective when the tube, fins or header plates are composed of aluminum. In assembling the modified form shown in Fig. 8, the tube sections are by preference inserted through the fins one at a time, although it is within the scope of this invention to insert them simultaneously. One of the marked advantages of flattening the return bends of the tube at both sides is that it permits the fins to be mounted upon the tube before either header plate is placed in position. If it were necessary to position one header plate before the fins were positioned on the tube, a certain difficulty in assembling the fins with the tube would be encountered in connection with holding the parts in proper position for relative movement into assembly, and this would be magnified in the production of coils having a plurality of sections or rows of tubes.

The relative motion of the tube and group of fins preferably takes place in a direction opposite to the lateral projection of the fin collars or flanges 7, 7, so that the said collars, so to speak, trail the motion and the possibility of deforming them is avoided. These collars serve not only as spacing elements for the fins but also extend and improve the thermal contact between tube and fins, which contact is likewise extended by the fact that the fins embrace approximately three quarters of the circumference of the tube.

When in the claims I refer to "flattening" the curved portions of the tube, I intend to cover any distortion of their normally circular cross section with the result of imparting a shape having longer and shorter axes, and not to be limited to a completely flat formation.

While this invention has been above described as applied to the production of condensers and evaporators used in unit products such as a window unit designed for air conditioning, it is applicable to the production of heat transfer coils which comprise a tube, fins and header

plates designed for any purpose; and I desire it also to be understood that various changes may be resorted to in the steps followed, the order of the steps, and the materials employed, without departing from the spirit or scope of the invention, so that I do not intend to be limited to details herein shown or described except as the same may be included in the claims or be required by disclosures of the prior art.

What I claim is:

1. A method of assembling heat transfer coils which includes the following steps: bending a tube into a sinuous form comprising substantially straight parallel portions connected by curved portions; flattening said curved portions at both sides of the bent tube; providing a plurality of fins each having series of apertures conforming in shape to but slightly larger than the combined cross section of a flattened curved portion and its connecting straight portions of the tube; providing header plates each having a series of apertures corresponding to the apertures in the fins; causing relative movement of the bent tube and fins in line with the straight portions of the tube to seat the fins on said straight portions; causing similar relative movement of the tube and header plates to seat the latter on said straight portions; and thereafter expanding the straight portions of the tube to bring them into operative contact with the fins and header plates thereon and expanding the flattened curved portions to at least approximately their original form.

2. A method as defined in claim 1, in which the parts are composed of such material that the fins and header plates are not amenable to union with the tube by soldering.

3. A method as defined in claim 1, in which the tube is cuprous and the fins and header plates are aluminic.

4. A method as defined in claim 1, in which the tube, fins and header plates are aluminic.

5. A method as defined in claim 1, which also includes the steps of aligning the plurality of fins by placing them in a rack or the like prior to seating them on the straight portions of the tube; and precisely positioning the header plates on the straight portions of the tube by the use of a jig or the like prior to expanding the straight portions of the tube.

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